US EPA Mid-Continent Ecology Division

Research Project Summary

Lake Superior Comparative Watershed Framework

Overview

The Comparative Watershed Framework allows us to test hypotheses concerning aquatic ecosystem vulnerability within a watershed context, and to develop diagnostic indicators of field responses to nonchemical stressors. Our scientific objectives are to: 1) Understand structural/functional relationships in watersheds of low-order streams; 2) Determine effects of spatio-temporal landscape patterns on aquatic ecosystem integrity and sustainability; 3) Develop methods to systematically discriminate among the effects of multiple stressors; 4) Understand the nature of cumulative impacts in watersheds and how cumulative impacts can be partitioned among, and traced to, physical, chemical, and biological stressors; and 5) Develop methods to predict and extrapolate multiple stressors and responses across watersheds.

The five-year Comparative Watershed Study began in 1996 with study site selection and field reconnaissance activities. The geographic focus is the western arm of Lake Superior, the "back yard" of the Mid-Continent Ecology Division-Duluth, but this research has nationwide applications as well. Twenty-four second order streams within two contrasting hydrogeomorphic regions, the North Shores Highlands and the Lake Superior Clay Plains, were chosen as study sites in 1996 (Fig. 1), and another 24 third order streams were chosen for study in 1998-99. A Geographic Information System (GIS) was used to select from each region three replicate watersheds in each of four treatment categories. Study watersheds were located with high and low degrees of forest fragmentation, both with and without extensive inland wetlands (Fig. 2a,b). We examined a wide array of endpoints, including habitat, hydrology, water quality, and biota (periphyton, macroinvertebrate, and fish communities). The Comparative Watershed Project has yielded a watershed classification system for the western arm of Lake Superior, allowing managers to categorize watersheds according to level of risk from nonpoint source stressors (Fig. 3). The Comparative Watershed approach has since been tested in other regions, including the Lake Michigan basin and the State of West Virginia.

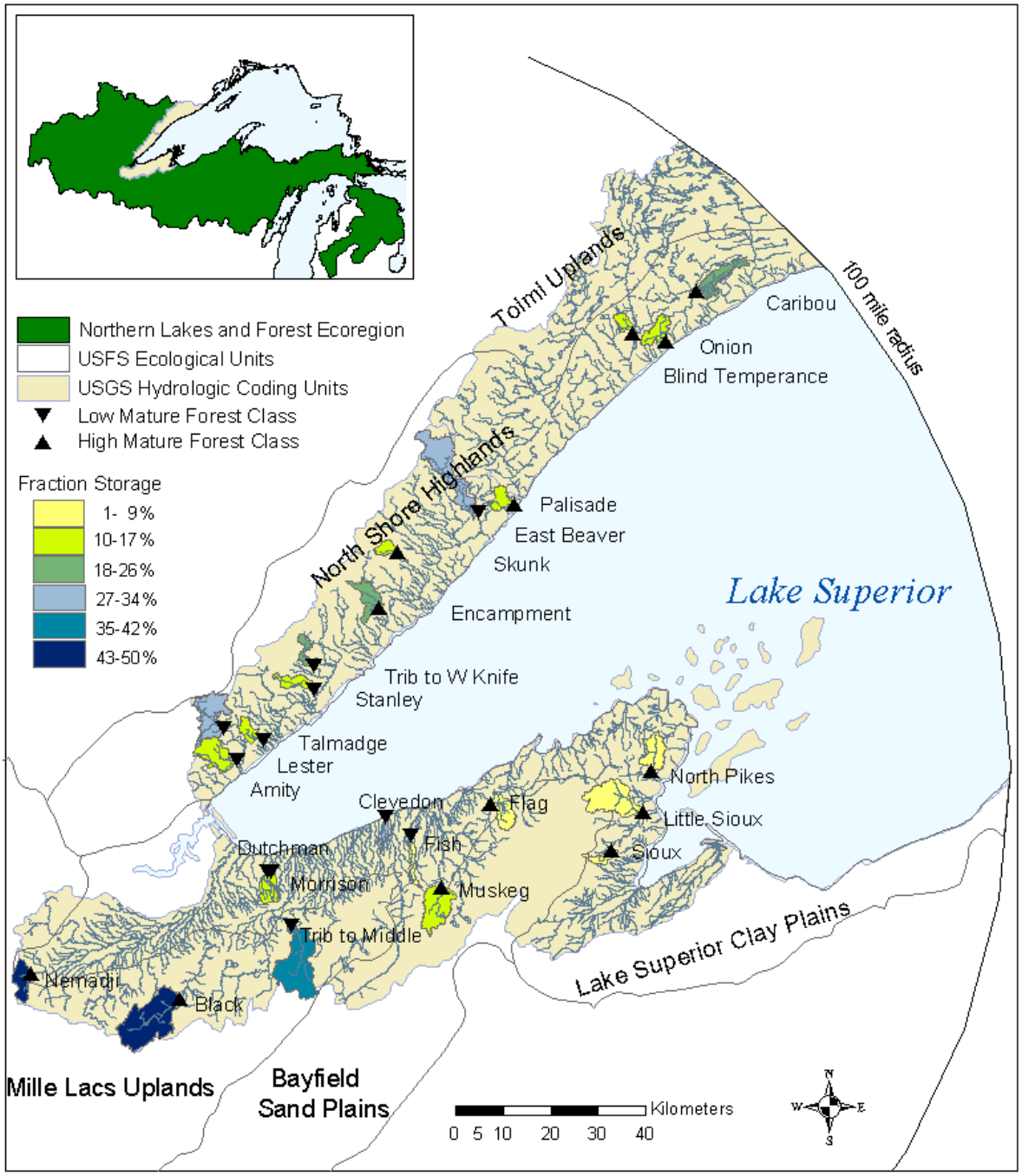
Northern Lakes and Forest Ecoregion
USFS Ecological Units
USGS Hydrologic Coding Units
Low Mature Forest Class
High Mature Forest Class
Fraction Storage
1- 9%
10-17%
18-26%
27-34%
35-42%
43-50%
Toimi Uplands
100 mile radius
Caribou
Onion
Blind Temperance
North Shore Highlands
Palisade
East Beaver
Skunk
Encampment
Lake Superior
Trib to W Knife
Stanley
Talmadge
Lester
Amity
North Pikes
Clevedon
Flag
Little Sioux
Fish
Sioux
Dutchman
Morrison
Muskeg
Trib to Middle
Lake Superior Clay Plains
Nemadji
Black
Mille Lacs Uplands
Bayfield
Sand Plains
Kilometers
0 5 10 20 30 40
N
W
E
S

Figure 1

Figure 2a

Figure 2b

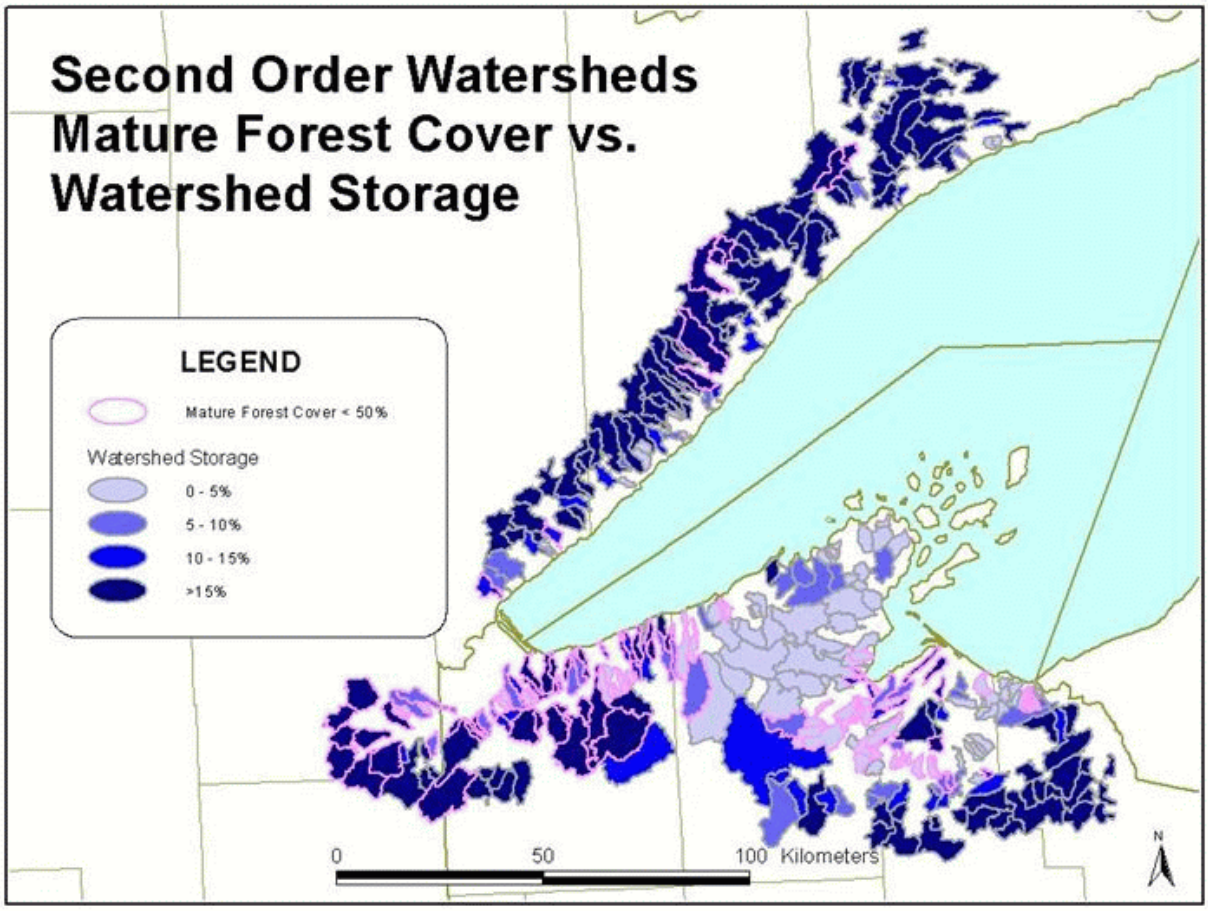
Second Order Watersheds
Mature Forest Cover vs.
Watershed Storage
LEGEND
Mature Forest Cover < 50%
Watershed Storage
0 - 5%
5 - 10%
10 - 15%
>15%
0
50
100 Kilometers
N

Figure 3

Key Products

Detenbeck NE, Batterman SL, Brady VJ, Brazner JC, Snarski VM, Taylor DL, and Thompson JA (2000) A test of watershed classification systems for ecological risk assessment. Environ Toxicol Chem 19:1174-1181.

Detenbeck NE, Elonen CM, Taylor, DL, Anderson, LE, Jicha, TM, and Batterman SL. (2003) Effects of hydrogeomorphic region, watershed storage, and mature forest on baseflow and snowmelt stream water quality in second-order Lake Superior Basin tributaries. Freshwater Biol 48(5):911-27.

Brazner JC, Tanner DK, Detenbeck NE, Batterman SL, Stark SK, Jagger LA, and Snarski VM. (2002a) Landscape influences on fish assemblage structure and function in western Lake Superior tributaries. Submitted to Environ Manage.

Brazner JC, Tanner DK, Detenbeck NE, Batterman SL, Stark SK, Jagger LA, and Snarski VM. (2002) Regional, watershed, and site-specific environmental influences on fish assemblage structure and function in western Lake Superior tributaries. To be submitted to: Can J Fish Aquat Sci.

http://www.epa.gov/med/watershed/group.htm

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